MOTOROLA INC., COMMUNICATIONS AND INDUSTRIAL ELECTRONICS DIVISION • INSTRUCTION MANUAL

MP MASTER
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S1050A
S1051A

TRANSISTORIZED AC VOLTMETER

PRINTED IN U. S. A.

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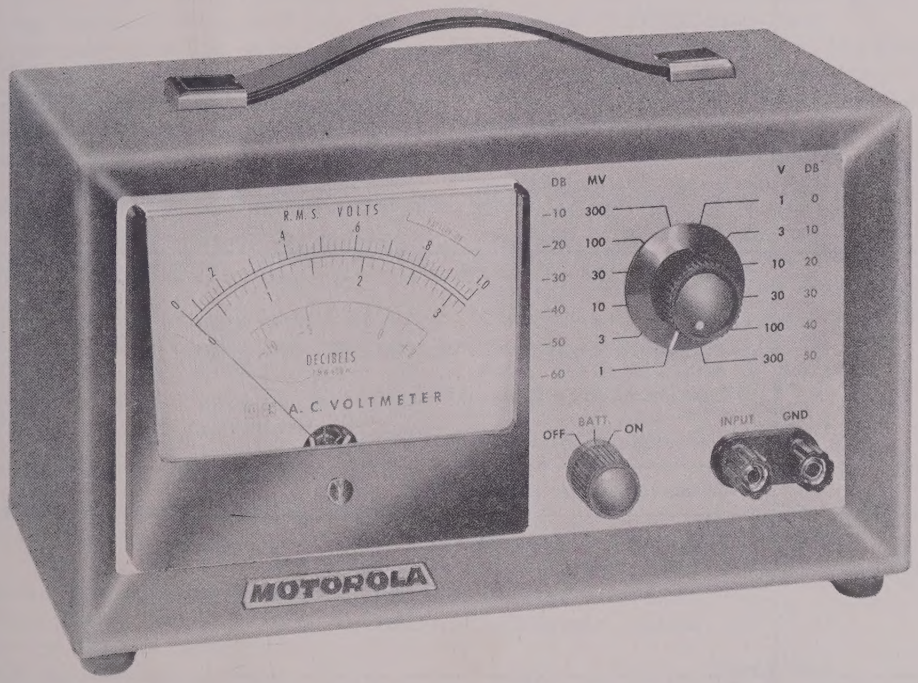
MOTOROLA

TRANSISTORIZED AC VOLTMETER

MODELS S1050A AND S1051A

MC5403 (R)



MODEL S1050A
TRANSISTORIZED AC VOLTMETER

MOTOROLA INC. COMMUNICATIONS DIVISION

Engineering Publications *4501 W. Augusta Blvd.* *Chicago 51, Illinois*

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GUARANTEED PERFORMANCE SPECIFICATIONS

MODEL	S1050A and S1051A AC Voltmeter
MEASUREMENTS	1 millivolt to 300 volts full scale on 12 ranges. -60 db to +50 db on 12 ranges.
ACCURACY	±3% from 20 cycles per second to 1 megacycle (25°C (45°F))
INPUT IMPEDANCE	1 to 300 mv range; greater than 1 megohm shunted by 30 uuf. 1 to 300 volt range; greater than 10 megohms shunted by 15 uuf.
OVERLOAD PROTECTION	VOLT range: Maximum of 550 volts (sum of the d-c and a-c peak voltages) MILLIVOLT range: Maximum of 110 volts rms continuous; 220 volts rms for 10 seconds or less; 600 volts d-c.
NOISE	Less than 0.2 mv meter deflection in open circuit input on the 1 mv scale. Less than 0.1 mv meter deflection in short circuit input on the 1 mv scale.
METER CALIBRATION	Linear voltage scales: 0-1 and 0-3 (calibrated to rms values of a sine wave). Voltages ranges: 1, 3, 10, 30, 100, 300 steps DB scale calibration: -12 to +2 Zero level: 1 milliwatt in 600 ohms.
METER	0-50 microampere movement
TRANSISTOR COMPLEMENT	(2) 2N231 - Preamplifiers (1) 2N231 - Buffer (2) 2N231 - Amplifier, 1st pair (2) 2N231 - Amplifier, 2nd pair
POWER SUPPLY	1 - 6.5 volt Mercury Battery (Mallory No. TR-135).
WEIGHT	Approximately 5 pounds - S1050A; 5-3/4 pounds - S1051A
DIMENSIONS	5" wide x 6" high x 10" long (approx.)

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

FOREWORD

CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

REPAIR AND/OR RECALIBRATION

It is suggested that the instrument be returned to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

for repair and/or recalibration. Before shipping the instrument notify the Parts and Service Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via Truck, Railway Express, Parcel Post, Air Freight or Air Express.

WARRANTY

Motorola instrument equipment other than tubes, fuses, vibrators, and batteries is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

Tubes and vibrators carry their own standard manufacturer's warranty of 90 days or 1000 hours, whichever first occurs.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

   Motorola Communication & Electronics, Inc.
   Parts & Service Department
   4910 West Flournoy Street
   Chicago 44, Illinois

   Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

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1. INTRODUCTION

a. Description

The Model S1050A and Model S1051A Transistorized AC Voltmeters are battery operated test instruments capable of performing the following functions:

(1) Measuring a-c voltages from 1 millivolt to 300 volts full scale within a frequency range of 20 cycles per second to 1 megacycle; with an accuracy of better than ±3%.

(2) Measuring voltages in the audio and intermediate frequency ranges for amplifier work.

(3) Measuring the quieting response of AM and FM receivers.

(4) Measuring null indications in both high and low frequency bridges.

(5) Measuring steady signal levels on telephone and remote control lines.

The two basic models differ only in one respect. The housing for the Model S1051A Transistorized AC Voltmeter has been designed to allow the use of a protective cover over the face of the instrument. This steel cover gives added protection against possible damage that may occur while transporting the instrument. Clips for storing the meter cable are mounted on the inside of the cover.

Although primarily designed for laboratory use, these instruments, being self-powered and housed in a sturdy steel case, are quite applicable for field use without sacrificing the accuracy or versatility of a laboratory test instrument.

b. Meter Cable

The SKN6001A Meter Cable is a 30" shielded cable, terminated on one end with a standard two-pin banana plug. Two small insulated alligator clips make up the probe end of the cable.

c. Instrument Characteristics

These instruments are similar to many other single function a-c voltmeters in that the meter movement responds to average values of the applied voltages. The meter scale is calibrated to read the rms value of the applied sinusoidal wave. When the input waveform departs from a pure sine wave, the meter indication will be in error by the ratio of the average value to the rms value of the incoming waveform. A table has been included in this manual to correct for the error involved when measuring non-sinusoidal waveforms.

2. METERING FACILITIES

The a-c voltmeter is calibrated in two linear a-c voltage scales, one decibel scale, and one battery voltage scale. The meter is a 0-50 microampere movement, with non-linearity less than 1% of full scale deflection. The meter damping has been adjusted to eliminate "overshoot" for convenience in reading the needle indication.

The meter scales and applications are as follows:

a. AC Voltage Scales

The two linear scales, in black, are for measuring rms values of a-c voltages. The upper scale is graduated to a full scale value of 1.0, while the lower scale has a full scale value of 3.2.

Using the full scale factors appearing on the Range Switch positions, all a-c voltages from 1 millivolt to 300 volts (rms) are read from these two scales.

b. Decibel Scale

The Decibel scale, in red, associated with the voltage scales, allows direct measurement of dbm (0 dbm being 1 milliwatt into a 600 ohm impedance). DB comparison can be made between two voltages, both measured at the same impedance level.

c. Battery Voltage Scale

The BATTERY OK Scale is the small scale above and to the right of the upper a-c voltage scale. It is used to measure the battery voltage under simulated load conditions. The needle position within the scale limits give a relative indication of the condition of the battery during its use in the instrument.

3. CONTROLS AND BINDING POSTS

All controls used for testing are located on the recessed front panel of the instrument. These controls include the following:

a. Range Selector Switch

The range selector switch is a 12-position switch used to select the proper voltage or decibel range for metering. The correct switch position will be determined by the level of the voltage applied.

b. OFF-BATT.-ON Switch

The OFF-BATT.-ON switch turns the instrument either off or on. When in the BATT. position, the meter is essentially connected across the battery to measure the voltage of the battery under simulated load conditions.

c. Binding Posts

The binding posts are mounted on a molded polystyrene base, selected for its low-loss characteristics at high frequencies.

These "six-way" binding posts are capable of making positive electrical connections using single and double pin banana plugs, tipped plugs, spade lugs, alligator clips and bare wire. The spacing between the two plugs allows the use of a 2-pin (GR) banana plug.

The ground post is directly connected to the instrument case. This should be taken into consideration when measuring circuits having a high d-c potential. Refer to the APPLICATIONS Section, paragraph a., for the proper procedure.

4. CIRCUIT DESCRIPTION

A fully transistorized a-c voltmeter offers many circuit advantages not found in a-c vacuum tube voltmeters. The advantages of small physical size and lighter weight are obvious. The use of a single battery, with an operating life of over 400 hours, gives complete portability for field use, without sacrificing accuracy. Freedom from a-c power lines reduces the effects of noise and harmonic frequencies on the meter reading. The absence of heat producing elements, such as tubes and transformers, lessens the need for frequent recalibration and increases the life of the individual components.

The a-c voltmeter is composed of the following four circuits:

a. Preamplifier

The function of the preamplifier is to provide a very high input impedance necessary in many applications. The circuit is composed of two 2N231 transistors in a so called "bootstrap" configuration. Through the use of feedback principles, the normally low input impedance of transistor amplifiers is raised to a higher value for accurate metering purposes. This reduces the loading effect on the circuit being measured.

The circuit incorporates two precision resistor attenuators. The input attenuator, used only on ranges over 1 volt, reduces the input signal by 60 db. The second attenuator, at the output of the preamplifier, is used to provide additional attenuation in 10 db steps.

Two protection diodes are connected to the base of the input transistor to protect the instrument from excessive input voltages. A maximum of 550 volts peak (sum of the a-c and d-c voltage) may be applied on any VOLT range without damage to the input circuit. A maximum of 110 volts rms continuous can be applied on any MILLIVOLT range; 220 volts rms for ten seconds or less.

b. Buffer

The buffer stage has a high input impedance as compared to the total resistance of the second attenuator. This stage allows effective isolation of the preamplifier and the attenuators from the low impedance input of the main amplifiers. A temperature compensating thermistor in the collector circuit corrects the gain variations at higher temperatures.

c. Amplifiers

The main amplifier section is composed of two cascoded amplifiers, each consisting of a pair of directly coupled transistors. The first pair is coupled to allow d-c feedback voltages for stabilization purposes. In both, the first and second pair, large amounts of a-c and d-c feedback are employed to insure stable operation over the wide bandwidth required for the instrument. To improve the stability of the instrument still further, three thermistors are used in different networks to compensate for the changing characteristics of the transistors and diodes due to temperature.

Capacitors, by-passing the emitter resistors, are used to shape the frequency characteristic to give a flat gain over the entire bandpass. Between the first and second pair of amplifiers, a variable gain control is used for calibrating purposes.

The second pair of amplifiers is similar to the first, with frequency and temperature compensation, and thermal stability being obtained in the same manner.

The output of the second amplifier is fed to a full wave rectifier composed of two high-frequency diodes. A large 50 microampere meter is used to measure the resulting d-c current from the rectifiers. The current is fed back into the second amplifier pair to provide the necessary feedback needed for accuracy and linearity over the entire bandwidth.

d. Decoupling Filter

Resistor R47 and Capacitor C14 constitutes a low frequency decoupling circuit between the second pair of amplifiers and the previous stages.

5. OPERATION

a. Battery Check

Turn the "OFF-BATT.-ON" Switch to the BATT. position. The meter needle should give an indication within the limits of the BATTERY OK scale. A fresh battery will give an indication near the upper limit of the scale. However, after one or two hours of operation, the meter indication should be at approximately mid-scale.

NOTE

After one or two hours of operation, the meter indication of the battery voltage should be noted for future reference. After several months of use, an appreciable change in the reading will occur. If the meter indication reaches, or falls outside of the lower limits of the BATTERY OK scale, the accuracy of the instrument is affected, and the battery should be replaced.

b. Operator's Instructions

With the meter leads disconnected, turn the "OFF-BATT.-ON" switch to the ON position. A rapid check of the instruments condition may be made by rotating the Range Selector Switch to the 1 MV position. The meter indication should be anywhere from 0.2 to full or off scale deflection, depending upon the proximity of stray electric fields (a-c power lines).

The a-c line voltage may be checked by connecting the test leads to the binding posts on the front panel, setting the Range Selector Switch to the 300 volt position, and measuring across an a-c line.

NOTE

Due to the great amount of variation of local line voltages, never calibrate this instrument using the a-c service line voltage as a reference.

To increase the life of the battery, the instrument should be turned off when not in use. As there is essentially no "warm up" time, the accuracy will not be affected by using the instrument immediately after turning it on.

The AC Voltmeter is now ready for use.

6. TEMPERATURE

As with most transistorized equipment, this instrument has certain temperature limitations. Under normal temperatures, the instrument will yield accurate readings. Care should be exercised to avoid operation and storage of the instrument in hot temperatures and direct sunlight. Storage at temperatures of less than -30°C should also be avoided. The following table will provide an idea of the accuracy of the instrument as influenced by temperature.

TYPICAL TEMPERATURE PERFORMANCE LIMITS

Temp.	Tolerance	Freq.
25°C (45°F)	±3%	20 cps to 1 mc
10°C to 25°C (18°F to 45°F)	±5%	20 cps to 1 mc
25°C to 50°C (45°F to 90°F)	±5%	20 cps to 1 mc
0°C (32°F)	±7% 0% to -10%	20 cps to 1 mc 500 kc to 1 mc
-10°C (-18°F)	±10% 0% to -20%	20 cps to 1 mc 500 kc to 1 mc

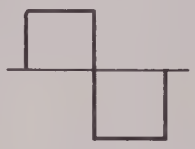
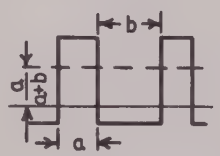
7. APPLICATIONS

a. General

A complete understanding of the instrument's capabilities and its effect on various circuits must be known in order to obtain the accurate measurements for which this test instrument was designed.

This instrument measures average voltage values of sinusoidal waveforms, while the meter scale is calibrated to read RMS values. For other than sinusoidal waveforms, the meter reading may be in error. Consequently, a meter correction table for non-sinusoidal waveforms is shown to give correction factors when the instrument is used for these applications. The average value of waveforms that do not have simple geometric configurations must be calculated by mathematical methods in order to obtain correct meter readings.

METER CORRECTION FACTOR TABLE

WAVEFORM	METER READING CORRECTION FACTOR
	1.0
	0.90
	1.04
	$\frac{.45(a+b)^{3/2}}{b\sqrt{a}}$

NOTE

The accuracy of the instrument can be maintained by annual or semi-annual calibration, preferably by the factory approved facility.

A typical characteristic of all a-c voltmeters of this type is their high input resistance and low shunt capacity. This input impedance must be taken into consideration when measuring across high impedances at high frequencies.

In situations where the ground terminal of the instrument is at a high d-c potential, a large coupling capacitor should be used for d-c blocking purposes. This prevents the instrument case from also being at a high d-c potential, and reduces shock hazards.

A brief outline of typical applications for the a-c voltmeter will be discussed to show the versatility of an instrument of this type. Unique uses for this instrument will be found as the capabilities of the instrument become more evident.

Specific

(1) Audio Frequency Measurements

Low level audio voltages generated in piezo-electric and magneto-strictive electro-mechanical devices (phonographic cartridges and microphones) may be accurately measured on the lower ranges of the meter.

Voltage levels in audio and ultra-sonic amplifiers using either electron tubes or transistors may also be measured without disrupting the circuit under test.

Decibel measurements may be made in the same manner as a-c voltage measurements. The decibel scale, associated with the voltage scales, allows direct measurement of dbm (0 dbm being 1 milliwatt into a 600 ohm nominal impedance). The decibel scale will only read dbm when measuring voltages across a 600 ohm impedance. DB comparison can be made between two voltages, both measured at the same impedance level.

Output voltages from power amplifiers, such as P.A. loudspeaker systems, may be measured across low impedance speakers and high impedance distribution lines without any loss of accuracy of the measuring instrument. However, do not exceed the maximum input voltage as specified in the GUARANTEED PERFORMANCE SPECIFICATIONS Chart included in this manual.

Hum levels on power supplies may also be measured. When excessively high d-c voltages are present, a .1 microfarad (or larger) series blocking capacitor should be used. Choose a capacitor with a d-c rating greater than that of the power supply under test.

(2) Radio Frequency Measurements

The a-c voltmeter will accurately measure voltage levels in i-f and r-f amplifiers, mixers, detectors, oscillators and modulators using either electron tubes or transistors. Measurements at these higher frequencies should be performed using very short direct leads between the voltmeter and the circuit under test. This will avoid the capacitive shunting effects which are inherent in shielded cables and long test leads.

The input resistance and shunt capacity of the instrument must be considered when measuring voltages at radio frequencies. The loading effect is most predominant on high impedance

tube circuits (especially on tuned circuits). The influence is considerably less on low impedance transistor circuits, where the shunt capacity of the instrument is normally a small part of the tuned circuit being measured.

The isolation from an a-c line makes the use of this instrument as a null indicator in a-c bridges very important. The high sensitivity and low internal noise allows an accurate balance of the bridge circuit to be made. Due to the wide frequency response of the instrument, it is important that the oscillator supplying the bridge be completely free from harmonics.

8. CALIBRATION

The calibration of the transistorized a-c voltmeter should only be attempted by qualified personnel having adequate testing facilities. In the event that these conditions are not fulfilled, the instrument should be returned to the factory for re-calibration.

The CALIBRATION PROCEDURE CHART included in this manual specifies the equipment required, the preliminary procedure, and the step-by-step calibration procedure.

NOTE

Any deviation from the procedure and information stated on the chart will result in improper calibration of the voltmeter.

9. MAINTENANCE

The Models S1050A and S1051A AC Voltmeters should be serviced by personnel qualified in maintaining laboratory test equipment. This is an accurate, sensitive instrument and should be treated as such. When qualified personnel and adequate test equipment are not available, the instrument should be returned to the factory Parts and Service Department for maintenance and calibration.

a. Battery Replacement

The battery should be replaced when the needle indicates a reading at or below the lower limits of the BATTERY OK scale. In order to replace the battery, proceed as follows:

(1) Pry out the large plug-button on the bottom of the housing.

(2) Pull on the button to remove the smaller plug-button which holds the battery in the case.

(3) Set the case in a normal up-right position; the battery will fall from its holder inside of the housing.

(4) Place a fresh battery in the holder, negative end first.

(5) Press the small plug-button back into the holder, and the large plug-button into the housing.

(6) Check the battery condition and polarity by turning the "OFF-BATT-ON" switch to the BATT position. The meter should provide an indication in the upper half of the BATTERY OK scale. Note that if the meter indication is below zero, the battery has been improperly placed in the holder. Remove the plug-button and reverse the position of the battery in the holder. Again replace the plug-buttons.

b. Meter Adjustment

If the meter needle does not rest over the zero line of the meter scale, make the proper adjustment by turning the screw on the meter cover left or right until the proper indication is obtained. This adjustment must be made with the instrument turned off.

c. Chassis Removal

NOTE

Remove the battery as previously described, before removing the chassis.

The chassis is fastened to the cabinet by means of four mounting screws located deep within the cabinet. Remove the two screws holding the back cover in place and slip the back cover out of the top groove in the housing. Next, remove the four chassis mounting screws and carefully lift out the chassis.

d. Printed Circuit Board Removal

With the chassis assembly removed from the cabinet, unsolder the ten leads as illustrated in the accompanying photo. Remove the six mounting screws holding the circuit board to the chassis, and remove the board.

e. Parts Replacement

Parts replacement is relatively simple in that all of the parts are exposed when the chassis

and printed circuit board are removed. The accompanying photo sectionalizes the printed circuit board into the major circuit divisions to aid in locating the individual components. Re-calibration is recommended after any servicing is completed.

NOTE

To prevent damage to the etched strips on the back of the board, use only a low wattage (22-1/2 watts max.) soldering iron.

f. Transistor Replacement

The transistors used in this instrument must be ordered from the factory. Refer to the parts list in the manual for the proper part number of the transistor in the corresponding circuit. The instrument should be re-calibrated after the replacement of a transistor.

g. Diode Replacement

The replacement of the diodes in the preamplifier and meter circuits should be handled in the same manner as the replacement of a transistor. These diodes should be ordered from the factory as they have certain electrical characteristics and are selected accordingly. Re-calibration should follow diode replacement.

The output of the second amplifier is fed to a full wave rectifier composed of two high-frequency diodes. A large 50 microampere meter is used to measure the resulting d-c current from the rectifiers. The current is fed back into the second amplifier pair to provide the necessary feedback needed for accuracy and linearity over the entire bandwidth.

d. Decoupling Filter

Resistor R47 and Capacitor C14 constitutes a low frequency decoupling circuit between the second pair of amplifiers and the previous stages.

5. OPERATION

a. Battery Check

Turn the "OFF-BATT.-ON" Switch to the BATT. position. The meter needle should give an indication within the limits of the BATTERY OK scale. A fresh battery will give an indication near the upper limit of the scale. However, after one or two hours of operation, the meter indication should be at approximately mid-scale.

NOTE

After one or two hours of operation, the meter indication of the battery voltage should be noted for future reference. After several months of use, an appreciable change in the reading will occur. If the meter indication reaches, or falls outside of the lower limits of the BATTERY OK scale, the accuracy of the instrument is affected, and the battery should be replaced.

b. Operator's Instructions

With the meter leads disconnected, turn the "OFF-BATT.-ON" switch to the ON position. A rapid check of the instruments condition may be made by rotating the Range Selector Switch to the 1 MV position. The meter indication should be anywhere from 0.2 to full or off scale deflection, depending upon the proximity of stray electric fields (a-c power lines).

The a-c line voltage may be checked by connecting the test leads to the binding posts on the front panel, setting the Range Selector Switch to the 300 volt position, and measuring across an a-c line.

NOTE

Due to the great amount of variation of local line voltages, never calibrate this instrument using the a-c service line voltage as a reference.

To increase the life of the battery, the instrument should be turned off when not in use. As there is essentially no "warm up" time, the accuracy will not be affected by using the instrument immediately after turning it on.

The AC Voltmeter is now ready for use.

6. TEMPERATURE

As with most transistorized equipment, this instrument has certain temperature limitations. Under normal temperatures, the instrument will yield accurate readings. Care should be exercised to avoid operation and storage of the instrument in hot temperatures and direct sunlight. Storage at temperatures of less than -30°C should also be avoided. The following table will provide an idea of the accuracy of the instrument as influenced by temperature.

TYPICAL TEMPERATURE PERFORMANCE LIMITS

Temp.	Tolerance	Freq.
25°C (77°F)	±3%	20 cps to 1 mc
10°C to 50°C (50°F to 122°F)	±5%	20 cps to 1 mc
0°C (32°F)	±7%	20 cps to 500 kc
	0% to -10%	500 kc to 1 mc
-10°C (14°F)	±10%	20 cps to 500 kc
	0% to -20%	500 kc to 1 mc

7. APPLICATIONS

a. General

A complete understanding of the instrument's capabilities and its effect on various circuits must be known in order to obtain the accurate measurements for which this test instrument was designed.

This instrument measures average voltage values of sinusoidal waveforms, while the meter scale is calibrated to read RMS values. For other than sinusoidal waveforms, the meter reading may be in error. Consequently, a meter correction table for non-sinusoidal waveforms is shown to give correction factors when the instrument is used for these applications. The average value of waveforms that do not have simple geometric configurations must be calculated by mathematical methods in order to obtain correct meter readings.

PRELIMINARY PROCEDURE

1. Remove the two small plug-buttons from the access holes on the bottom of the housing, and the single plug-button from the back cover.

2. Place the instrument in its normal operating position, approximately 10 to 18 inches above the work bench. (Support the instrument in the best manner available.)

3. With the OFF-BATT.-ON Switch in the OFF position, adjust the mechanical zero on the meter cover until the indicator rests directly over the zero line on the meter scale. (Tap meter lightly.)

4. Turn the OFF-BATT.-ON Switch to the BATT. position, and check the condition of the battery. The meter indication should be approximately mid-scale on the BATTERY OK Scale. If a new battery is needed, replace the old one as described in the MAINTENANCE SECTION of this manual.

NOTE

Leave the instrument "on" for approximately one hour before recalibration after a new battery has been installed.

EQUIPMENT REQUIRED

1. An a-f and r-f signal generator with less than 2% harmonic distortion.

2. An RMS reading voltmeter, capable of 1/4% full scale accuracy when reading between 1.0 millivolt and 1.0 volt at 20 cycles per second to 1.0 megacycle.

3. A completely non-metallic tuning tool.

STEP	PROCEDURE	RANGE SWITCH POSITION	APPLIED SIGNAL FREQUENCY	METER INDICATION
1	Turn the OFF-BATT.-ON switch to the ON position. Set the range switch in the **10MV position. Apply 9.0** mv. (±1/2%) at **400 cps** (±5%) to the input terminals. Adjust potentiometer R (bottom access hole toward rear) for a reading of 9.0 mv.	10MV	400 cps	9.0 mv.
2	With the RANGE switch in the **10MV position, apply** 9.0 mv. (±1/2%) at 800 kc (±5%) to the input terminals. Adjust capacitor C20 (bottom access hole toward front) for a reading of 9.0 mv. In the event the desired meter reading cannot be obtained, it will be necessary to experiment with the proper placement of capacitor C 21/C 22. (This capacitor may not be present).	10MV	800 kc	9.0 mv.
3	With the range switch to the 1V position, apply 0.9 volt (±1/2%) at 400 cps (±5%) to the input terminals. Note and record the meter reading.	1V	400 cps	0.9v (±0.005v)
	Now apply 0.9 volt **(±1/4%)** at 800 kc (±5%) to the input terminals and adjust capacitor C2 (back panel access hole) for a reading equal to that recorded with 400 cps input.	1V	800 kc	0.9v (±0.005v)
4	Repeat **step 3 to insure accurate adjustments.**	--	--	--
5	A final frequency response check should include test frequencies of **20** cps, 10 kc, 100 kc and 1 megacycle. With the range switch in the **10MV position,** apply 9.0 mv **(±1/4%) at each of the previously mentioned** frequencies (±5%) to the input terminals. The meter should read **9.0 mv (±0.2 mv).**	10MV	20 cps 10 kc 100 kc 1 mc	9.0 mv (±0.2 mv)
6	Replace all plug-buttons and turn instrument off.	--	--	--

PRELIMINARY PROCEDURE

1. Remove the two small plug-buttons from the access holes on the bottom of the housing, and the single plug-button from the back cover.

2. Place the instrument in its normal operating position, approximately 10 to 18 inches above the work bench. (Support the instrument in the best manner available.)

3. With the OFF-BATT.-ON Switch in the OFF position, adjust the mechanical zero on the meter cover until the indicator rests directly over the zero line on the meter scale. (Tap meter lightly if movement appears to be sticking.)

4. Turn the OFF-BATT.-ON Switch to the BATT. position, and check the condition of the battery. The meter indication should be approximately mid-scale on the BATTERY OK Scale. If a new battery is needed, replace the old one as described in the MAINTENANCE SECTION of this manual.

NOTE

Leave the instrument "on" for approximately one hour before recalibration after a new battery has been installed.

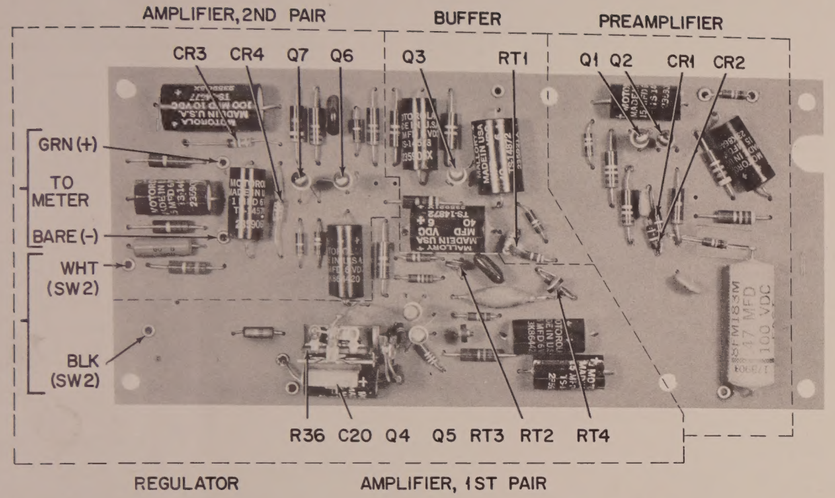
EQUIPMENT REQUIRED

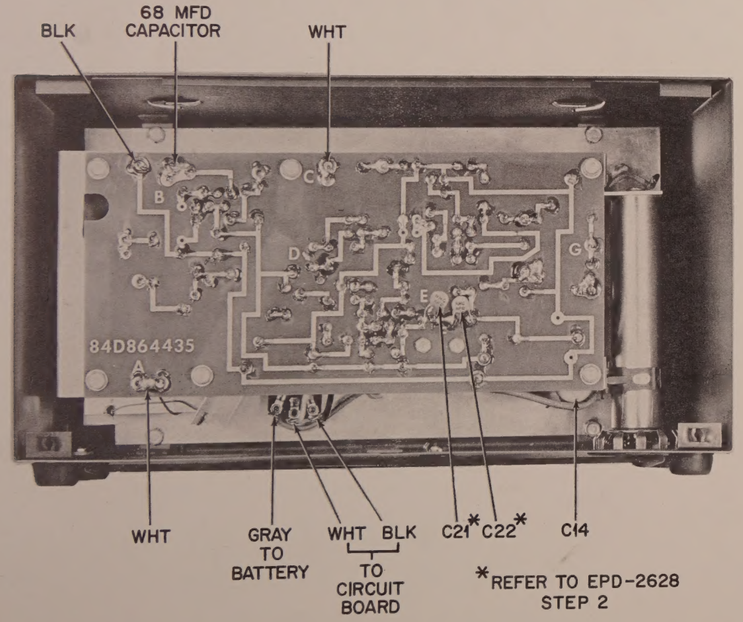
1. An a-f and r-f signal generator with less than 2% harmonic distortion.

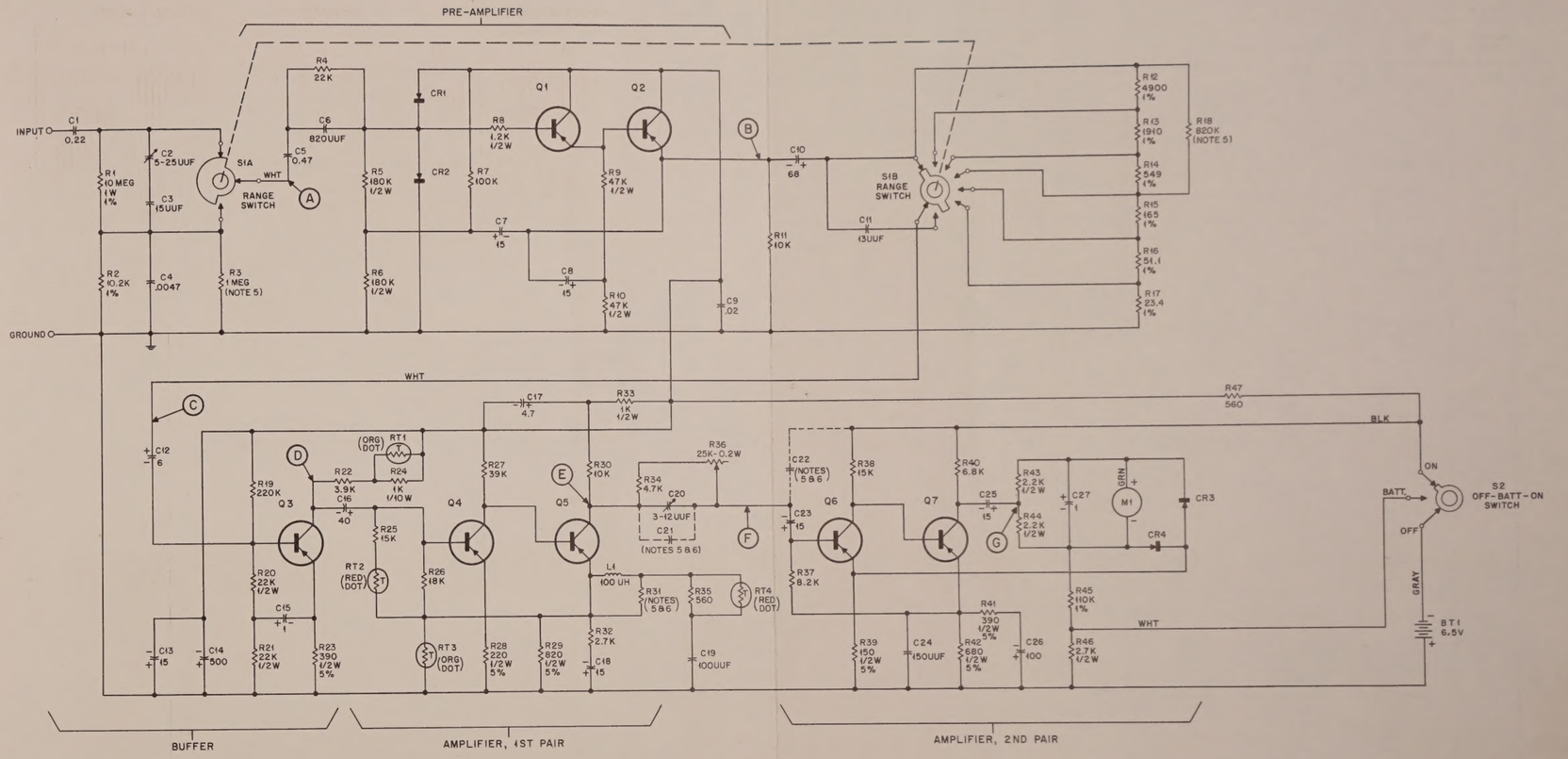
2. An RMS reading voltmeter, capable of 1/2% full scale accuracy when reading 1.0 millivolt and 1.0 volt at 20 cycles per second and at 1.0 megacycle.

3. A completely non-metallic tuning tool.

STEP	PROCEDURE	RANGE SWITCH POSITION	APPLIED SIGNAL FREQUENCY	METER INDICATION
1	Turn the OFF-BATT.-ON switch to the ON position. Set the range switch in the 1MV position. Apply 0.9 mv. (±1/2%) at 400 cps (±5%) to the input terminals. Adjust potentiometer R (bottom access hole toward rear) for a reading of 0.9 mv.	1MV	800 cps	0.9 mv.
2	With the RANGE switch in the 1MV position, apply 0.9 mv. (±1/2%) at 800 kc (±5%) to the input terminals. Adjust capacitor C20 (bottom access hole toward front) for a reading of 0.9 mv. In the event the desired meter reading cannot be obtained, it will be necessary to experiment with the proper placement of capacitor C 21/C 22. (This capacitor may not be present).	1MV	800 kc	0.9 mv.
3	With the range switch to the 1V position, apply 0.9 volt (±1/2%) at 800 cps (±5%) to the input terminals. Note and record the meter reading.	1V	800 cps	0.9v (±0.02v)
	Now apply 0.9 volt (±1/2%) at 800 kc (±5%) to the input terminals and adjust capacitor C2 (back panel access hole) for a reading equal to that recorded with 800 cps input.	1V	800 kc	0.9v (±0.02v)
4	Repeat steps 2 and 3 to insure accurate adjustments.	--	--	--
5	A final frequency response check should include test frequencies of 30 cps, 10 kc, 100 kc and 1 megacycle. With the range switch in the IMV position, apply 0.9 mv (±1/2%) at each of the previously mentioned frequencies (±5%) to the input terminals. The meter should read 0.9 mv (±0.03 mv).	1MV	30 cps 10 kc 100 kc 1 mc	0.9 mv (±0.03 mv)
6	Replace all plug-buttons and turn instrument off.	--	--	--







NOTES:

1. RANGE SWITCH SHOWN IN 1 MILLIVOLT POSITION, FULL COUNTER-CLOCKWISE (AS VIEWED FROM FRONT).
2. RESISTORS ARE 1/4 W, ±10%, UNLESS OTHERWISE SPECIFIED.
3. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
4. ENCIRCLED BOLD LETTERS ARE TEST POINTS INDICATED ON CIRCUIT BOARD.
5. COMPONENT VALUE ADJUSTED AT FACTORY, COMPONENT MAY OR MAY NOT BE PRESENT.
6. WHEN USED, PART IS ON PRINTED SIDE OF CIRCUIT BOARD.

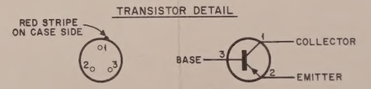


DIAGRAM NO. 63D862131

Schematic Diagram and Parts Location Details
Motorola No. 63D862131-O

national

MOTOROLA

RADIO COMMUNICATIONS

service

MP MASTER

MA36305